

## **Reliability and Maintainability Engineering – A major driver for Safety and Affordability**

**Fayssal M. Safie**

*NASA/MSFC, Huntsville, Al, USA, [fayssal.m.safie@nasa.gov](mailto:fayssal.m.safie@nasa.gov)*

### ***Abstract***

The United States National Aeronautics and Space Administration (NASA) is in the midst of an effort to design and build a safe and affordable heavy lift vehicle to go to the moon and beyond. To achieve that, NASA is seeking more innovative and efficient approaches to reduce cost while maintaining an acceptable level of safety and mission success. One area that has the potential to contribute significantly to achieving NASA safety and affordability goals is Reliability and Maintainability (R&M) engineering. Inadequate reliability or failure of critical safety items may directly jeopardize the safety of the user(s) and result in a loss of life. Inadequate reliability of equipment may directly jeopardize mission success. Systems designed to be more reliable (fewer failures) and maintainable (fewer resources needed) can lower the total life cycle cost.

The Department of Defense (DOD) and industry experience has shown that optimized and adequate levels of R&M are critical for achieving a high level of safety and mission success, and low sustainment cost. Also, lessons learned from the Space Shuttle program clearly demonstrated the importance of R&M engineering in designing and operating safe and affordable launch systems. The Challenger and Columbia accidents are examples of the severe impact of design unreliability and process induced failures on system safety and mission success. These accidents demonstrated the criticality of reliability engineering in understanding component failure mechanisms and integrated system failures across the system elements' interfaces. Experience from the shuttle program also shows that insufficient Reliability, Maintainability, and Supportability (RMS) engineering analyses upfront in the design phase can significantly increase the sustainment cost and, thereby, the total life cycle cost. Emphasis on RMS during the design phase is critical for identifying the design features and characteristics needed for time efficient processing, improved operational availability, and optimized maintenance and logistic support infrastructure.

This paper discusses the role of R&M in a program acquisition phase and the potential impact of R&M on safety, mission success, operational availability, and affordability. This includes discussion of the R&M elements that need to be addressed and the R&M analyses that need to be performed in order to support a safe and affordable system design. The paper also provides some lessons learned from the Space Shuttle program on the impact of R&M on safety and affordability.